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FERMENTED MANIOCAN FLOUR (*Manihot esculenta. Crantz*) ENRICHED WITH MORINGA (*Moringa oleifera. Lam*) FOR ANIMAL AND HUMAN FEED

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ABSTRACT

In order to enrich the fermented cassava flour, a mixture of the wet fermented cassava and moringa leaf powder was made and for this, cassava of the tame type was acquired in the municipality of Quibala and moringa in the municipality of Sumbe both in the province of Kwanza Sul, both cassava and moringa were transported to the Research Center for Food Technology (CEPTA), attached to the Faculty of Veterinary Medicine in Huambo. The moringa leaves were dried in shade and open air for five days, then pulverized in a traditional mortar, sieved in a 1mm sieve, packaged and stored for later use. The cassava was cleaned, peeled, washed in running water and put to ferment in a stainless steel metal drum with water acidified with lemon, after five days of fermentation, it was removed from the water and placed in raffia bags suspended for 24h to drain the water, Later it was crushed and passed through a sieve (sieve) to obtain the flour that with this same moisture weighed 1kg that were mixed with 164g of moringa powder and resulted in a composition in dry matter of 5.46% crude protein, 0.07% crude fiber, 2% fat, 78.76% carbohydrate, 4.88% ash, 9% moisture, 0.27% vitamin C and 93% dry matte.

Keys word: cassava, fermented flour, moringa

INTRODUTION

The world population is predicted to grow to 10 billion in 2050, but changes in diet and food production are anticipated with a growing population led by Metropolis urbanisation [1]. The high intake of high fat dairy products, red meat, processed meat, prepackaged foods, butter, fried foods, high sugar drinks among others have an increasingly negative effect on health and the environment [2,3]. For, the interest currently is to shift to a more plant-based diet to improve human health, sustainable food production, reduce pollution, land and water use [4,1]. Cassava cultivation in Angola is of great importance due to the fact that it is easy to grow, rustic and has good productivity, for example world production in 2016 was 277.1 million tons [5] in this production Angola ranked as the seventh largest world producer of cassava with approximately 10 million tons. Cassava is grown in almost the entire country with 79% production concentrated in the provinces of Uige, Malange, Zaire, Kwanza Norte, Lunda Norte, Lunda Sul and Cabinda [6]. Moringa is a plant grown in tropical and subtropical climates [7]. One of the parts of the plant that can be used is the leaf in which green mass production is around 5-6t/ha [8]. From a nutritional and medicinal point of view moringa contains proteins, fats, essential amino acids, vitamin A, B complex vitamins, minerals (iron, zinc, phosphorus, potassium, copper among others) and bioactive substances such as tannins, flavonoids, quercetin, saponins, terpenoids, sterols among others [9]. These compounds together are what enrich the plant and it is attributed a great versatility of use in both food and folk medicine. The goal of this research was to enrich fermented cassava flour with moringa leaf powder to serve as a health food for its richness in nutrients for humans and animals.

MATERIALS AND METHODS

The work was developed at the Centre for Research in Food Technology (CEPTA) of the Faculty of Veterinary Medicine in the period between March and September 2021. To this end, manioc was acquired from Victoria Farm in the municipality of Kibala (Huambo-Angola) and moringa was harvested in the municipality of Sumbe precisely in the district E15, both localities belonging to the province of Kwanza-Sul. The moringa and cassava were transported to Huambo where they were processed at the Centre for Technological Food Processing (CEPTA), the moringa leaves were dehydrated in the shade

in the open air for 10 days, after drying they were pulverized in a traditional mortar and passed through a 1mm sieve, the powder was packed and stored for the procedure of mixing with moist cassava flour. The cassava was washed in running water, peeled with the help of a stainless steel knife, sanitized and placed in a stainless steel metal drum with water and put to ferment for five days, after this period, it was removed from the water and placed in raffia bags, suspended for 24 hours to drain the water. Afterwards it was disintegrated by hand and passed in a 1mm sieve to convert it into moist flour. 1kg of moist flour was weighed to which 164g of moringa powder was added and homogenized manually in a plastic tray, after mixing they were taken to dry directly in the not too burning sun. From this mixture 500g were taken and sent to the Laboratorio Agroalimentario of the Ministry of Agriculture, Fisheries and Forestry in Luanda to perform physico-chemical analyses (crude protein, crude fibre, ether strata and vitamin C). For the determination of crude protein, the Kjeldahl method was used which basically consists in the determination of the protein fraction, where the nitrogen present in the sample is transformed into ammonium and subsequently separated by distillation and quantified by titration of the distillate with a standardised solution of hydrochloric or sulphuric acid. For the determination of crude fibre the Weende method was used. For ashes the Gravimetric method was used by the use of an oven at 110ºC and muffle furnace where it was incinerated at 550ºC. The moisture content and dry matter were determined by the gravimetric method. This method consists in heating the sample under specific conditions and using the weight loss to calculate the moisture content of the sample. The method used for the fat determination was the Soxhlet method. In this method, the free fat content is determined by direct extraction with petroleum ether or diethyl ether or another type of solvent. All analyses were performed in triplicate. The carbohydrate content was calculated by difference using the following expression:

ENN = 100 – (PB + FB+EE + MM + H).

RESULTS AND DISCUSSION

From the process of obtaining the fermented flour and addition of powder of moringa leaves, resulted in a powder of grayish colour with smell of fermented cassava. By submitting the two flours under the bromatological analyses, the fermented flour with the addition of moringa showed higher parameters than the plain fermented cassava flour, which demonstrates its enrichment in nutritional terms, table1.

Table 1. Bromatological parameters of FF and FFmo in percentage in dry matter

	PB	FB	EE	CZ	COH	MS	H	VIT C
FF	**0,38**	**0,02**	**0,27**	**0,46**	**88**	**89,2**	**10,8**	**0,01**
FFmo	**5,46**	**0,07**	**2**	**5**	**79**	**91**	**9**	**0,27**

FF= fermented flour, FFmo= flour fermented with moringa

As shown in table 1, the crude protein in dry matter of fermented cassava flour with the addition of moringa is five times higher than in plain fermented cassava flour because, the increment in protein is very visible and is essentially due to this mixture since, moringa is a rich source of protein and other components as demonstrated by several references and examples are Olugbemi *et al*, [10] who evaluated the chemical composition of moringa leaves and found 28% crude protein; 7.10% crude fibre; 5.9% ethereal extract, 2.5% calcium, 0.30% phosphorus and 12.2% ash. Almeida [11] demonstrated the existence of 27% crude protein, 2% ethereal extract, 19% crude fibre, 17% vitamin C and 38% carbohydrates. For this reason, moringa is an alternative source of various nutrients that can serve to enrich other foods for human and animal consumption. Thus, it is also perceptible to observe the increment of all other nutrients in the table except carbohydrate. Verem *et al*., [12] obtained an increase in several nutrients, including crude protein by mixing wheat, soybean and moringa flour in different proportions for the enrichment of wheat.

Regarding the composition of fermented cassava, [13] found protein content that ranged from 0.57 to 1.38%, ethereal stratum of 0.30 to 1.02%, ash 0.16 to 1.64% and moisture between 1.45 to 8.39%, which reveals to be a product of low nutrient content, as demonstrated in this study.

The moisture content in plain fermented flour and in mixture with moringa is acceptable since it is within the parameters required for these types of flour which is a maximum of 13% [14]. For carbohydrate it is required in fermented flour a minimum content of 70%, and

as can be seen the two flours are within the required parameters to present 88% and 79% respectively.

Other elements to take into account in moringa are without doubt the bioactive components that give it pharmacological properties, because these compounds may be present in flour.

This flour can be considered as a health food for the therapeutic activities that are described to moringa and can be used in feeding programs for the malnourished. Jesus et al., [15] makes reference to the use of moringa in the diet of warriors, whereby, it was believed to add strength and endurance during battles. Currently, the search for alternative and healthy foods derived from plants constitute a premise worldwide for the benefits they bring to health and the environment. Springmann *et al*., [16] stated that there is a connection between an individual's diet, public health and environmental sustainability.

Chronic diseases reported because of unhealthy diets such as type II diabetes, cardiovascular diseases and cancers, require high costs in treatment [17], thus it is of great importance the study that relates food to health. The knowledge of the constituents of food is of utmost importance for the evaluation of the potential of the product to be consumed or raw material to be used in food preparation, as well as for the knowledge of its nutritional value [13].

CONCLUSION

The addition of moringa leaf powder in fermented cassava flour provided an increment of crude protein and other essential components that can serve for feeding programs due to its acceptability

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